

PATENT ABSTRACTS OF JAPAN

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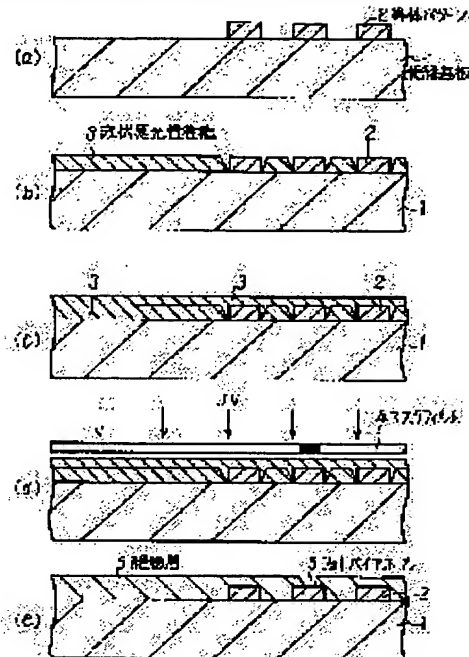
(72)Inventor : ISHIDOU KIMINORI

(54) MANUFACTURE OF PRINTED CIRCUIT BOARD

(57)Abstract:

PURPOSE: To provide a manufacturing method for a printed circuit board with uniform thickness, in which an insulating layer can be formed between fine-pitch conductors in pattern.

CONSTITUTION: A manufacturing method includes a step for forming a conductive pattern 2 on an insulating pattern 1, a step for applying aqueous photosensitive resin 3 to an area other than the conductive pattern 2 while a voltage is applied in an electrostatic spray method and drying in a dry-to-touch way, and a step for exposing, developing, hardening by ultraviolet rays and curing by heat using a mask film 4. In these steps, a printed circuit board with a photo-viahole 5 can be formed.



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CLAIMS

[Claim(s)]

[Claim 1] The process which forms a conductor pattern on an insulating substrate by the etching method, The process which carries out the discharge set to touch of the liquefied photopolymer to the field which left the conductor pattern of the product area of said insulating substrate with the electrostatic spray method where an electrical potential difference is impressed to this conductor pattern, The manufacture approach of the printed circuit board characterized by carrying out laminating spreading of said liquefied photopolymer all over an insulating substrate by the spray coating method or the curtain coat method, and including the process which carries out the set to touch, and the process which performs exposure, development, the ultraviolet-rays effectiveness, and heat curing one by one through a mask film.

[Claim 2] The process which forms a conductor pattern and the pad for component mounting on an insulating substrate by the etching method, The process which carries out the discharge set to touch of the liquefied photopolymer to the field which left said conductor pattern and the pad for component mounting of product area of said insulating substrate with the electrostatic spray method where an electrical potential difference is impressed to this conductor pattern and the pad for component mounting, The process which forms a solder dam in the gap of the deed aforementioned conductor pattern and the pad for component mounting for exposure, development, and ultraviolet curing one by one through a mask film, The process which carries out laminating spreading and carries out the set to touch of said liquefied photopolymer all over said insulating substrate, The manufacture approach of the printed circuit board characterized by including the process which leaves the part of said conductor pattern which formed said solder dam through the mask film, and the pad for component mounting, and performs exposure, development, ultraviolet curing, and heat curing one by one.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] Especially this invention relates to the manufacture approach of the printed circuit board containing the formation process of an insulating layer using a liquefied photopolymer about the manufacture approach of a printed circuit board.

[0002]

[Description of the Prior Art] Conventionally, the approach of applying conductive liquefied photosensitivity solder resist with an electrostatic spray method as an approach of forming an insulating layer on an insulating substrate using a liquefied photopolymer is indicated by JP,2-257698,A. Drawing 6 (a) - (c) is a perspective view explaining the method of application of conductive liquefied photosensitivity solder REIZUTO of the conventional example indicated by JP,2-257698,A. First, as shown in drawing 6 (a), the regurgitation of the conductive liquefied photosensitivity solder resist is carried out to the whole table surface A of an insulating substrate 1 with the bell mold spray gun 12 of an electrostatic method. Liquefied photosensitivity solder resist is applied all over the table of an insulating substrate 1 by operation of an insulating substrate 1 and the lure plate 14 which gives conductivity seemingly to an insulating substrate 1 non-contact. Next, as shown in drawing 6 (b), front flesh-side reversal of the insulating substrate 1 is carried out, and as shown in drawing 6 (c), the regurgitation of the conductive liquefied photosensitivity solder resist is similarly carried out to the whole flesh-side surface B of an insulating substrate 1. Subsequently, after performing the set to touch for [85 degrees-C] -5 minutes and making conductive liquefied photosensitivity solder resist into a tuck free-lancer, a desired solder-resist pattern is obtained by performing double-sided simultaneous exposure and development through a mask film, and performing ultraviolet curing and heat curing further.

[0003]

[Problem(s) to be Solved by the Invention] Form an insulating layer and a photograph BAIA hole using the conventional liquefied photopolymer, and it sets to the so-called insulating stratification of the surface patchboard with a conductor layer serially manufactured by the laminating. By the approach of using an electrostatic spray method and applying a conductive liquefied photopolymer on the insulating substrate in which the conductor pattern was formed especially An ink particle tended to be caught by operation of a lure plate, and the industrial advantage in which application effectiveness is excellent as a result had the trouble that an insulating layer with uniform thickness was not obtained by the reason of the liquid lappet of resin of a certain thing etc. with the wiring consistency of a conductor pattern. Moreover, in the formation of an insulating layer to an outer layer, since there was a limitation of precision also in film doubling of exposure, it was difficult to form an insulating layer in the gap of the conductor pattern which has a narrow pitch.

[0004] The object of this invention has uniform thickness and is to offer the manufacture approach of the printed circuit board which can form an insulating layer also in the gap of the conductor pattern which has a narrow pitch.

[0005]

[Means for Solving the Problem] The process at which the manufacture approach of the printed circuit board the 1st invention forms a conductor pattern on an insulating substrate by the etching method, The process which carries out the discharge set to touch of the liquefied photopolymer to the field which left the conductor pattern of the product area of said insulating substrate with the electrostatic spray method where an electrical potential difference is impressed to this conductor pattern, It is characterized by carrying out laminating spreading of said liquefied photopolymer all over an insulating substrate by the spray coating method or the curtain coat method, and including the process which carries out the set to touch, and the process which performs exposure, development, the ultraviolet-rays effectiveness, and heat curing one by one through a mask film.

[0006] The process at which the manufacture approach of the printed circuit board the 2nd invention forms a conductor pattern and the pad for component mounting on an insulating substrate by the

etching method, The process which carries out the discharge set to touch of the liquefied photopolymer to the field which left said conductor pattern and the pad for component mounting of product area of said insulating substrate with the electrostatic spray method where an electrical potential difference is impressed to this conductor pattern and the pad for component mounting, The process which forms a solder dam in the gap of the deed aforementioned conductor pattern and the pad for component mounting for exposure, development, and ultraviolet curing one by one through a mask film, It is characterized by including the process which carries out laminating spreading and carries out the set to touch of said liquefied photopolymer all over said insulating substrate, and the process which leaves the part of said conductor pattern which formed said solder dam through the mask film, and the pad for component mounting, and performs exposure, development, ultraviolet curing, and heat curing one by one.

[0007]

[Example] Next, the example of this invention is explained with reference to a drawing.

[0008] Drawing 1 (a) The sectional view having shown – (e) in order of the process explaining the 1st example of this invention, the block diagram of the outline explaining the mechanism of the electrostatic spray method which uses drawing 2 for the 1st example, and drawing 3 are the partial amplification perspective views of the insulating substrate of drawing 2 . First, the 1st example of this invention forms the conductor pattern 2 with a plating thickness of 20 micrometers in an insulating substrate 1 by the etching method, as shown in drawing 1 (a). Next, as shown in drawing 1 (b), drawing 2 , and drawing 3 , the regurgitation of the liquefied photopolymer 3 which gave the high tension of -40kV of bell mold spray guns of an electrostatic method by 12 where the electrical potential difference of -200V is impressed to the lead wire 11 linked to the conductor pattern 2 prepared in the appearance range which is the area 16 outside a product of an insulating substrate 1 is carried out to the product area 15 of an insulating substrate 1. At this time, the liquefied photopolymer 3 controls the amount of discharge flow to be applied to 20 micrometers equivalent to the plating thickness of a conductor pattern 2. It repels each other's liquefied photopolymer 3 charged in negative with the conductor pattern with which the electrical potential difference is impressed, and, as a result, it is applied only on an insulating substrate 1. It is better not to use it here, since a lure plate reduces the repulsive force of the liquefied photopolymer 3. While the liquefied photopolymer 3 is breathed out by the insulating substrate 1, the equipment design of the electrical-potential-difference impression is carried out so that the power-source probe 13 may contact lead wire 11. That is, ON of the regurgitation, ON of OFF and probe contact, and OFF are performed simultaneously. Next, as shown in drawing 1 (c), the liquefied photopolymer 3 is applied all over an insulating substrate 1 so that the thickness on a circuit may be set to 30–40 micrometers by the spray coating method or the curtain coat method. This 2nd resin coat has the desirable approach which printing pressure does not require for the resin painted surface before desiccation, and screen printing, the roll coat method, etc. are not suitable. The spreading process of these single strings can also be performed conveying an insulating substrate 1 by conveyor etc. Next, as shown in drawing 1 (d), after making the liquefied photopolymer 3 into a tuck free-lancer by the set to touch for 80 degree-C–30 minutes, A mask film 4 is minded and the addition quantity of light is $50 - 200 \text{ mJ/cm}^2$. As it exposes so that it may become, and shown in drawing 1 (e) The spray development for 60 – 120 seconds, and addition quantity of light 200 mJ/cm^2 The printed circuit board by the 1st example of this invention which comes to provide the insulating layer 6 which has the photograph BAIA hole 5 by performing ultraviolet curing and heat curing for [150 degrees-C] –30 minutes one by one is obtained.

[0009] Drawing 4 (a) – (e) and drawing 5 (a) – (b) is the sectional view shown in order of the process explaining the 2nd example of this invention. First, the 2nd example of this invention forms the conductor pattern 2 with a plating thickness of 55 micrometers and the pad pitch 0.3mm pad 7 for component mounting in an insulating substrate 1 by the etching method, as shown in drawing 4 (a). Next, as shown in drawing 4 (b), the regurgitation of the liquefied photosensitivity solder resist 8 which gave the high tension of -40kV with the bell mold spray gun of an electrostatic method where the electrical

potential difference of -200V is impressed to the lead wire 11 linked to the pad 7 for component mounting prepared in the appearance range which is the area 16 outside a product of drawing 3 of an insulating substrate 1 is carried out to the product area 15 of drawing 3 of an insulating substrate 1. Next, as shown in drawing 4 (c), after making liquefied photosensitivity solder resist 8 into a tuck free-lancer by the set to touch for [80 degrees-C] -30 minutes, a mask film 4 is minded, and the addition quantity of light is 400 - 1000 mJ/cm². It exposes so that it may become. next, it is shown in drawing 4 (d) -- as -- the spray development for 60 - 120 seconds, the addition quantity of light 200 - 1000 mJ/cm². The solder dam 9 is formed in the clearance between the pads for component mounting by performing ultraviolet curing one by one. Next, as shown in drawing 4 (e), the liquefied photosensitivity solder resist 8 is applied using a well-known technique, for example, screen printing. Subsequently, as shown in drawing 5 (a), the set to touch of the liquefied photosensitivity solder resist 8 is carried out, and it exposes through a mask film 4. At this time, the part of the pad 7 for component mounting in which the solder dam 9 was formed is made unexposed. Next, as shown in drawing 5 (b), the printed circuit board by the 2nd example of this invention which comes to provide the desired solder-resist pattern 10 is obtained by performing development, ultraviolet curing, and heat curing one by one.

[0010]

[Effect of the Invention] It is effective in the ability to be able to form an insulating layer in the clearance between the conductor patterns which can form an insulating layer with uniform thickness, without being related to the wiring consistency of a conductor pattern, and have ** Bitsch further, since this invention is in the condition which impressed the electrical potential difference to the conductor pattern formed on the insulating substrate by the etching method, and apply to the product area of an insulating substrate with an electrostatic spray method and discharge and a liquefied photopolymer apply all over an insulating substrate by the spray coating method or the curtain coat method for a liquefied photopolymer as having explained above.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] (a) - (e) is the sectional view shown in order of the process explaining the 1st example of this invention.

[Drawing 2] It is the block diagram of the outline explaining the mechanism of the electrostatic spray method used for the 1st example.

[Drawing 3] It is the partial amplification perspective view of the insulating substrate of drawing 2.

[Drawing 4] (a) - (e) is the sectional view shown in order of the process explaining the 2nd example of this invention.

[Drawing 5] (a) - (b) is the sectional view shown in order of the process explaining the 2nd example of

this invention.

[Drawing 6] (a) - (c) is a perspective view explaining the method of application of the conventional conductive liquefied photosensitivity resist indicated by JP,2-257698,A.

[Description of Notations]

- 1 Insulating Substrate
 - 2 Conductor Pattern
 - 3 Liquefied Photopolymer
 - 4 Mask Film
 - 5 Photograph BAIA Hole
 - 6 Insulating Layer
 - 7 Pad for Component Mounting
 - 8 Liquefied Photosensitivity Solder Resist
 - 9 Solder Dam
 - 10 Solder-Resist Pattern
 - 11 Lead Wire
 - 12 Bell Mold Spray Gun
 - 13 Power-Source Probe
 - 14 Lure Plate
 - 15 Product Area
 - 16 Area outside Product
-

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(71) 出願人 000004237

日本電気株式会社

東京都港区芝五丁目7番1号

(72) 発明者 石堂 仁則

東京都港区芝五丁目7番1号 日本電気株式会社内

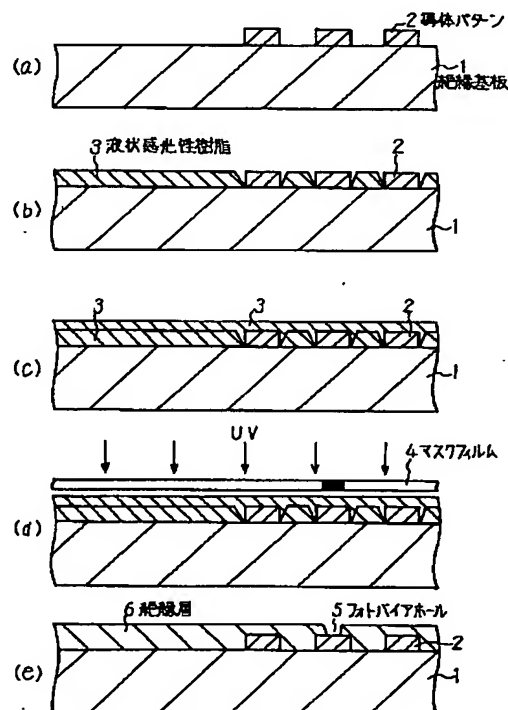
(74) 代理人 弁理士 京本 直樹 (外2名)

(54) 【発明の名称】 印刷配線板の製造方法

(57) 【要約】

【目的】 厚みが均一で、狭小ピッチを有する導体パターンの間隙にも絶縁層を形成できる印刷配線板の製造方法を提供する。

【構成】 絶縁基板1上に導体パターン2を形成する工程と、この導体パターン2に電圧を印加した状態で静電スプレー方式により絶縁基板1の製品エリアの導体パターン2を残した領域に液状感光性樹脂3を塗布し指触乾燥する工程と、絶縁基板1全面に液状感光性樹脂3を積層塗布し指触乾燥する工程と、マスクフィルム4を介して露光、現像紫外線硬化および熱硬化を順次行う工程とを含み、フォトリソホール5を有する印刷配線板を得る。



(2)

【特許請求の範囲】

【請求項1】 エッチング法によって絶縁基板上に導体パターンを形成する工程と、この導体パターンに電圧を印加した状態で静電スプレー方式により前記絶縁基板の製品エリアの導体パターンを残した領域に液状感光性樹脂を吐出し指触乾燥する工程と、スプレーコート法あるいはカーテンコート法により絶縁基板の全面に前記液状感光性樹脂を積層塗布し指触乾燥する工程と、マスクフィルムを介して露光、現像、紫外線効果および熱硬化を順次行う工程とを含むことを特徴とする印刷配線板の製造方法。

【請求項2】 エッチング法によって絶縁基板上に導体パターンおよび部品実装用パッドを形成する工程と、この導体パターン及び部品実装用パッドに電圧を印加した状態で静電スプレー方式により前記絶縁基板の製品エリアの前記導体パターンと部品実装用パッドを残した領域に液状感光性樹脂を吐出し指触乾燥する工程と、マスクフィルムを介して露光、現像および紫外線硬化を順次行い前記導体パターンと部品実装用パッドの間隙にソルダダムを形成する工程と、前記絶縁基板の全面に前記液状感光性樹脂を積層塗布し指触乾燥する工程と、マスクフィルムを介して前記ソルダダムを形成した前記導体パターンと部品実装用パッドの部位を残して露光、現像、紫外線硬化および熱硬化を順次行う工程とを含むことを特徴とする印刷配線板の製造方法。

【発明の詳細な説明】

【0001】

【産業上の利用分野】 本発明は印刷配線板の製造方法に関し、特に液状感光性樹脂を用いた絶縁層の形成工程を含む印刷配線板の製造方法に関する。

【0002】

【従来の技術】 従来、液状感光性樹脂を用いて絶縁基板上に絶縁層を形成する方法として、導電性の液状感光性ソルダレジストを静電スプレー方式により塗布する方法が、特開平2-257698号公報に開示されている。図6(a)～(c)は特開平2-257698号公報に開示された従来例の導電性の液状感光性ソルダレジストの塗布方法を説明する斜視図である。まず、図6(a)に示す如く、静電方式のベル型スプレーガン12により絶縁基板1の表全面Aに導電性の液状感光性ソルダレジストを吐出する。液状感光性ソルダレジストは絶縁基板1と非接触で絶縁基板1に見掛上導電性をもたせるおとり板14の作用により、絶縁基板1の表全面に塗着される。次に、図6(b)に示す如く、絶縁基板1を表裏反転させ、図6(c)に示す如く、同様に絶縁基板1の裏全面Bにも導電性の液状感光性ソルダレジストを吐出する。次いで、85℃-5分間の指触乾燥を行い、導電性の液状感光性ソルダレジストをタックフリーとした後、マスクフィルムを介して両面同時露光、現像を行い、更に紫外線硬化および熱硬化を行うことで所望のソルダ

ジストパターンを得る。

【0003】

【発明が解決しようとする課題】 従来の、液状感光性樹脂を用いて絶縁層およびフォトバイアホールを形成し、導体層との逐次積層によって製造される、いわゆる表層配線板の絶縁層形成において、特に、導体パターンの形成された絶縁基板上に、導電性の液状感光性樹脂を静電スプレー方式を用いて塗布する方法では、おとり板の作用によってインク粒子が捕捉されやすく、その結果塗着効率が優れるという工業的長所はあるものの、樹脂の液垂れ等の理由により導体パターンの配線密度によって厚みの均一な絶縁層が得られないという問題点があった。又、外層への絶縁層の形成においては、露光のフィルム合わせにも精度の限界がある為、狭小ピッチを有する導体パターンの間隙に絶縁層を形成することは困難であった。

【0004】 本発明の目的は、厚みが均一で、狭小ピッチを有する導体パターンの間隙にも絶縁層を形成できる印刷配線板の製造方法を提供することにある。

【0005】

【課題を解決するための手段】 第1の発明の印刷配線板の製造方法は、エッチング法によって絶縁基板上に導体パターンを形成する工程と、この導体パターンに電圧を印加した状態で静電スプレー方式により前記絶縁基板の製品エリアの導体パターンを残した領域に液状感光性樹脂を吐出し指触乾燥する工程と、スプレーコート法あるいはカーテンコート法により絶縁基板の全面に前記液状感光性樹脂を積層塗布し指触乾燥する工程と、マスクフィルムを介して露光、現像、紫外線効果および熱硬化を順次行う工程とを含むことを特徴とする。

【0006】 第2の発明の印刷配線板の製造方法は、エッチング法によって絶縁基板上に導体パターンおよび部品実装用パッドを形成する工程と、この導体パターン及び部品実装用パッドに電圧を印加した状態で静電スプレー方式により前記絶縁基板の製品エリアの前記導体パターンと部品実装用パッドを残した領域に液状感光性樹脂を吐出し指触乾燥する工程と、マスクフィルムを介して露光、現像および紫外線硬化を順次行い前記導体パターンと部品実装用パッドの間隙にソルダダムを形成する工程と、前記絶縁基板の全面に前記液状感光性樹脂を積層塗布し指触乾燥する工程と、マスクフィルムを介して前記ソルダダムを形成した前記導体パターンと部品実装用パッドの部位を残して露光、現像、紫外線硬化および熱硬化を順次行う工程とを含むことを特徴とする。

【0007】

【実施例】 次に、本発明の実施例について図面を参照して説明する。

【0008】 図1(a)～(e)は本発明の第1の実施例を説明する工程順に示した断面図、図2は第1の実施例に用いる静電スプレー方式のメカニズムを説明する概

(3)

略の構成図、図3は図2の絶縁基板の部分拡大斜視図である。本発明の第1の実施例は、まず、図1(a)に示すように、エッチング法によって絶縁基板1にめっき厚 $20\mu\text{m}$ の導体パターン2を形成する。次に、図1

(b)、図2および図3に示すように、絶縁基板1の製品外エリア16である外形範囲に設けた導体パターン2と接続するリード線11に -200V の電圧を印加した状態で静電方式のベル型スプレーガン12により -40KV の高電圧を与えた液状感光性樹脂3を絶縁基板1の製品エリア15に吐出する。この時、液状感光性樹脂3は導体パターン2のめっき厚と同等の $20\mu\text{m}$ に塗布されるように吐出流量を制御する。負に帯電した液状感光性樹脂3は電圧の印加されている導体パターンと反発し合い、その結果絶縁基板1上にもみ塗着する。ここでは、おとり板は液状感光性樹脂3の反発力を低下させるので用いない方がよい。電圧印加は絶縁基板1に液状感光性樹脂3が吐出されている間、リード線11に電源プローブ13が接触するよう装置設計する。即ち、吐出のON、OFFとプローブ接触のON、OFFは同時に行う。次に、図1(c)に示すように、液状感光性樹脂3をスプレーコート法、あるいはカーテンコート法によって回路上の膜厚が $30\sim 40\mu\text{m}$ になるように絶縁基板1の全面に塗布する。この第2の樹脂コートは、乾燥前の樹脂塗装面に印圧のかからない方法が好ましく、スクリーン印刷法、ロールコート法等は適切でない。これら一連の塗布工程は、絶縁基板1をコンベア等で搬送しながら行うことも出来る。次に、図1(d)に示すように、 $80^\circ\text{C}-30$ 分の指触乾燥によって液状感光性樹脂3をタックフリーとした後、マスクフィルム4を介して積算光量が $50\sim 200\text{mJ}/\text{cm}^2$ となるように露光を行い、図1(e)に示すように、 $60\sim 120$ 秒間のスプレー現象、積算光量 $200\text{mJ}/\text{cm}^2$ の紫外線硬化、 $150^\circ\text{C}-30$ 分間の熱硬化を順次行うことで、フォトバイアホール5を有する絶縁層6を具備してなる本発明の第1の実施例による印刷配線板を得る。

【0009】図4(a)～(e)、図5(a)～(b)は本発明の第2の実施例を説明する工程順に示した断面図である。本発明の第2の実施例は、まず、図4(a)に示すように、エッチング法によって絶縁基板1にめっき厚 $55\mu\text{m}$ の導体パターン2及びパッドピッチ 0.3mm の部品実装用パッド7を形成する。次に、図4

(b)に示すように、絶縁基板1の図3の製品外エリア16である外形範囲に設けた部品実装用パッド7と接続するリード線11に -200V の電圧を印加した状態で静電方式のベル型スプレーガンにより -40KV の高電圧を与えた液状感光性ソルダレジスト8を絶縁基板1の図3の製品エリア15に吐出する。次に、図4(c)に示すように、 $80^\circ\text{C}-30$ 分間の指触乾燥によって液状感光性ソルダレジスト8をタックフリーとした後、マスクフィルム4を介して積算光量が $400\sim 1000\text{mJ}$

$/\text{cm}^2$ になるように露光を行う。次に、図4(d)に示すように、 $60\sim 120$ 秒間のスプレー現象、積算光量 $200\sim 1000\text{mJ}/\text{cm}^2$ の紫外線硬化を順次行うことで、部品実装用パッドの隙間にソルダダム9を形成する。次に、図4(e)に示すように、液状感光性ソルダレジスト8を公知技術、例えばスクリーン印刷法を用いて塗布する。次いで、図5(a)に示すように、液状感光性ソルダレジスト8を指触乾燥しマスクフィルム4を介して露光を行う。この時、ソルダダム9を形成した部品実装用パッド7の部位は未露光とする。次に、図5(b)に示すように、現像、紫外線硬化、熱硬化を順次行うことで、所望のソルダレジストパターン10を具備してなる本発明の第2の実施例による印刷配線板を得る。

【0010】

【発明の効果】以上説明したように本発明は、エッチング法によって絶縁基板上に形成した導体パターンに電圧を印加した状態で、液状感光性樹脂を静電スプレー方式により絶縁基板の製品エリアに吐出し、液状感光性樹脂をスプレーコート法、あるいはカーテンコート法により絶縁基板の全面に塗布するので、導体パターンの配線密度に関係することなく厚さの均一な絶縁層を形成でき、更に狭ピッチを有する導体パターンの隙間に絶縁層を形成できるといった効果がある。

【図面の簡単な説明】

【図1】(a)～(e)は本発明の第1の実施例を説明する工程順に示した断面図である。

【図2】第1の実施例に用いる静電スプレー方式のメカニズムを説明する概略の構成図である。

【図3】図2の絶縁基板の部分拡大斜視図である。

【図4】(a)～(e)は本発明の第2の実施例を説明する工程順に示した断面図である。

【図5】(a)～(b)は本発明の第2の実施例を説明する工程順に示した断面図である。

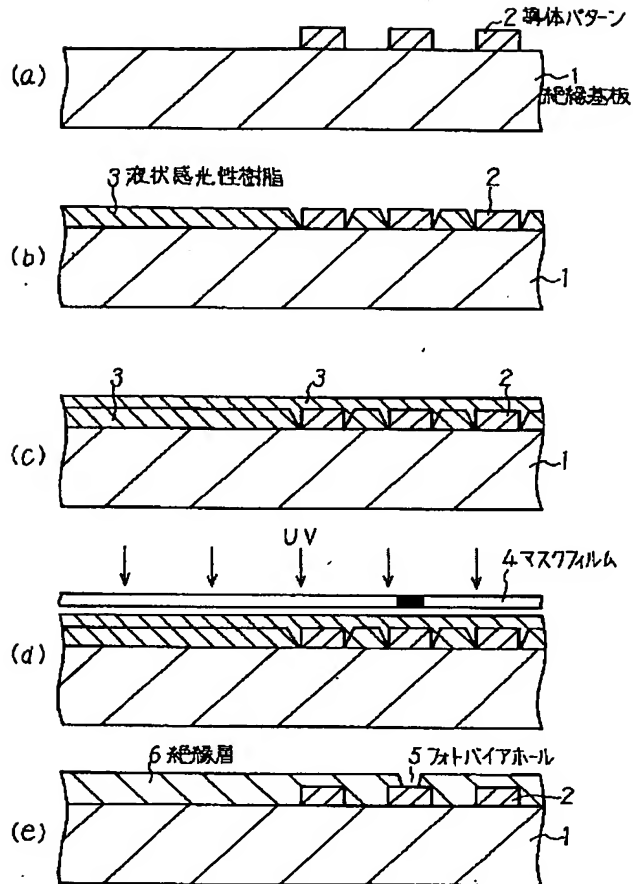
【図6】(a)～(c)は特開平2-257698号公報に開示された従来の導電性の液状感光性レジストの塗布方法を説明する斜視図である。

【符号の説明】

- | | |
|----|--------------|
| 1 | 絶縁基板 |
| 2 | 導体パターン |
| 3 | 液状感光性樹脂 |
| 4 | マスクフィルム |
| 5 | フォトバイアホール |
| 6 | 絶縁層 |
| 7 | 部品実装用パッド |
| 8 | 液状感光性ソルダレジスト |
| 9 | ソルダダム |
| 10 | ソルダレジストパターン |
| 11 | リード線 |
| 12 | ベル型スプレーガン |

13 電源プローブ
14 おとり板

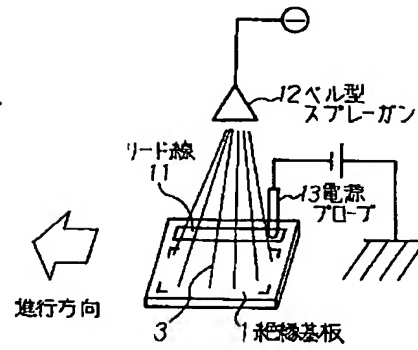
【図1】



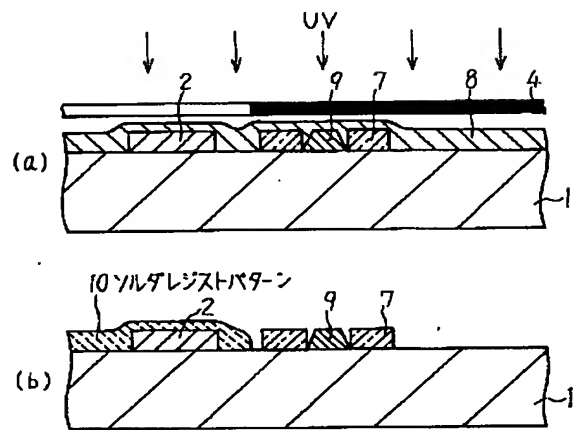
(4)

15 製品エリア
16 製品外エリア

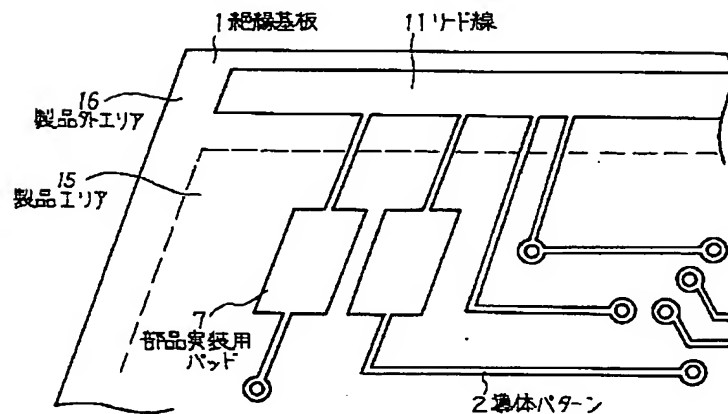
【図2】



【図5】

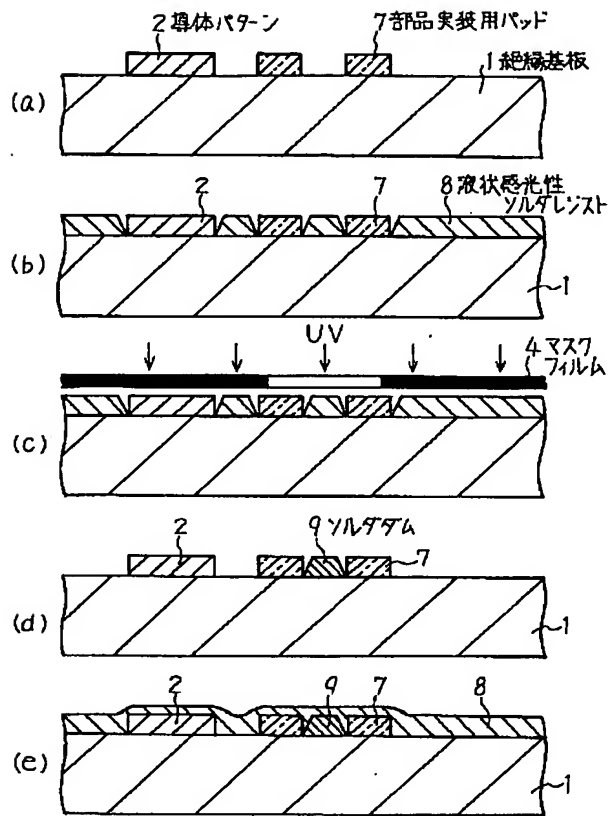


【図3】

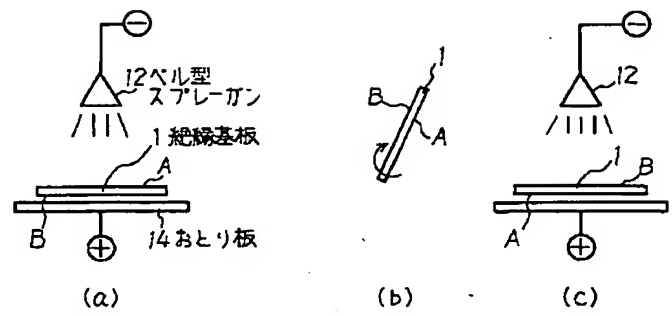


(5)

【図4】



【図6】



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